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DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

A Letter to My Brother: Peak Oil in Greater Detail

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This is a guest post by Alan Drake, a letter he sent to his youngest brother.

Peak Oil in Greater Detail

"Oil companies should fire all of their geologists and geophysicists and hire economists to replace them since economists are SO much better at finding oil".
---- Old Saying in the oil patch

Here's some random facts to illustrate how inelastic supply of oil is once an oil province hits it's "Hubbert Peak" and the super giant fields deplete...

In 1972, Texas produced more oil than ever before, up by 40 percent during the previous 10 years at relatively low prices. In the next 10 years, the price of oil increased ten fold (1000%). Drilling exploded far above any historic record. The success rate plummeted, the number of producing wells increased by only 14%, and oil production dropped back to 1962 levels in 1982.

1962-1972 Texas
Price stable, up slightly
Production +40%

1972-1982 Texas
Price +1000%
Production –28%

2002-2015 Saudi Arabia ?

The last two super giant oil fields found in the world were both found in Kazakhstan. One in the late 1980s and the other in 2000. The last field, Kashagan (expected to produce 1 million b/day at peak) is now thought likely to go into production in 2012 and full production shortly thereafter. (ANWR has about a 5% probability of being a supergiant per one estimate (USGS ?)).

13 years from discovery to production for remaining frontier areas (ANWR is estimated as 10 years from lease to first production and 16 to 20 years till peak production).
25+ years since a super giant was discovered outside Kazakhstan

10% of all the oil ever consumed was consumed in GW Bush's first term. By some estimates, 10% of all the conventional oil left will be consumed in his second term. This is the power of exponential growth.

EROEI (Energy return on energy invested) is declining for oil production from 100:1 in 1960s (world wide) to 8:1 today. Energy used in oil production is largely oil and natural gas.

Corn ethanol has an EROEI of about 1.3:1, sugar cane ethanol 6 to 8:1 (better with manual harvesting), Canadian tar sands are about 4:1.

At Peak Coal in UK (1913), 18% of the coal produced was used for coal production. EROEI of 5.3:1 not counting the solar energy indirectly fueling the mules.

The Export Land Model is that as oil prices rise, oil exporting nations economies boom and domestic consumption rises rapidly (and domestic markets are shielded from price signals for political reasons). Oil exports thus decline much faster than oil production. In 2006, Russia was a textbook case of Export Land as production rose modestly but exports fell modestly with about a 5% spread. The Finance Minister of Russia predicts the same thing for 2007-2009. The Energy Minister of Russia warns of a production crash after 2010.

Under the partially true and partially false assumption that oil exporters will not restrain domestic oil consumption as their economies boom, and a modest decline in EROEI, world oil exports could decline by half in six years after the second year post-Peak Oil. The impact of such a drop in oil exports, or anything remotely close, would be profound !

Saudi Arabia has redeveloped all of their oil fields with horizontal wells located at the level where the rising water level is expected to one day meet the growing gas cap. This includes Ghawar which is believed to have produced 5 million b/day (~60% of Saudi production) just a few years ago. Another field redeveloped this way, Yibal in Yemen, crashed (-80% in 3 years from memory) when water met gas. Ghawar is larger (170 miles by up to 20 miles wide) and will not crash uniformly like Yibal, but large million b/day sections of Ghawar will crash sequentially and there are repeated rumors that one section of Ghawar has crashed and others are on the verge of collapse.

Saudi Aramco is making heroic efforts to redevelop once abandoned oil fields. One field, Manifa, is considered a sure bet for 900,000 b/day once refineries in SA and China are completed that can handle it's problematic oil. The other abandoned oil fields are considered unlikely to produce the quoted volumes by experts who once worked on those fields before abandonment but they will produce some oil.

The range of responsible estimates for Saudi maximum production capacity in 2010/2012 vary by 5 million b/day. That is 6% of current total world oil production (unconventional adjusted for energy content) of ~84 million b/day. Given the short term inelasticity of demand for oil, that 5 million b/day is the delta between 80 euros/barrel and 200 euros/barrel. And that delta has profound economic, social and political implications. Thus the concentration upon any hint of the truth beneath the sands.

North Sea oil production (UK, Norway, Denmark) is dropping by –9% to –14% every year (UK will be flat in 2007 as one last oil field comes on-line and it's production will equal declines elsewhere).

Mexico got 60% of their production (and 100% of their exports) from one field in 2004, Cantarell. Cantarell appears to be in annual decline of –20% to –25% and, with growing domestic consumption, Mexican oil exports should decline from 2+ million b/day to about 250,000 b/day by 1/1/11.

US oil production goes down by about 250,000 b/day every year. We should be flat the year that Thunder Horse finally goes into production (originally scheduled for 2005, now 2009 ?).

Canadian tar sands production is being expanded faster than the infrastructure can support, with projected unit costs doubling and tripling and project after project being delayed. Production should expand to 3 million b/day by 2015 (or 2017) from 1.25 million b/day today. 1/3rd to ½ of this new tar sand production (with low EROEI) will offset declines in Canadian conventional oil production. Resource constraints appear to limit maximum production to 5 million b/day and that level may not be sustainable long term.

Angola, the newest member of OPEC, is a bright spot in world oil production, with a realistic chance of expanding production and exports by 1 million b/day (not true for any other nation except Venezuela and perhaps Canada and Kazakhstan). Over a half million Chinese are working in Angola on a variety of projects and China got the most recent offshore oil lease.

Libya and Algeria appear to have opportunities for modest production increases.

Kuwait is now declining, but at a modest rate of perhaps 4% or 5% per year. The recently democratically elected parliament is advocating major production cuts to make the remaining oil "last 100 years". "Oil in the ground is better than dollars in a bank".

Iran appears to be facing an oil export squeeze as their oil production declines and population grows. They will have to depend much more upon natural gas exports. Their aggressive hydroelectric building program gives support to their need for nuclear electricity in order to reduce domestic NG use.

Indonesia is a small oil exporter by value and a small importer by volume. Brazil is debating whether to preserve a small surplus for future domestic use or become a small exporter.

Nigeria, like Iraq, is in such chaos that production forecasts are difficult, but downward pressure seems likely in both. Both have older reservoirs and the Iraqi ones appear to have been badly abused.

Light sweet crude oil has already peaked with no prospect of ever recovering. Depending on one's definition of "Light sweet", the peak was in 2000 or 2004. Production is already down well over 10% from the peak.

The most conservative definition of oil, crude plus condensate, has peaked in May 2005 and demand should test if this production level can be equaled in June 2007.

The Oil Drum has looked repeatedly and exhaustively at alternatives. Every approach advocated by the Bush Administration is technical nonsense. Hydrogen, corn & switchgrass ethanol are deeply flawed.

The Oil Drum has also come to the conclusion that there is no one single answer or "silver bullet" exists. Instead a variety of silver BBs will be required.

Sugar cane ethanol will be viable for some domestic demand in tropical nations, and Japan has recently signed up most of Brazil's near term ethanol export potential (a week before Bush's visit).

Biosource butanol is an overlooked alternative that more R&D resources should be applied to but it is decades away from 1 million b/day. Algae farm bio-diesel (using special oil rich species) is

"interesting" but it is even further away than bio-butanol.

Light hydrocarbons (compressed natural gas, propane, butane) can assume a much larger role in transportation, but their availability is in question (a few years delay in Peaking after Oil). The rule of thumb is that US drilling rigs must increase by 10% every year to keep US NG production stable (we have already peaked and are well into the process of moving NG using industry abroad). NG imports from Canada seem likely to decline as tar sands and other domestic uses increase there and US LNG imports seem unlikely to increase dramatically for a variety of reasons.

None the less, a viable strategy is a dramatic reduction in the use of light hydrocarbons for electrical generation and water heating (with improved insulation offsetting increased space heating demand as NG space heating displaces heating oil) and redirecting these fuels towards transportation. Again, almost a decade may be required for a significant shift (say 5% of US transportation). One silver BB.

Venezuelan asphalt is considered a better resource than Canadian tar sands, but the US either sponsored or supported a failed coup d'etat against the democracy there. Any future development will be done with domestic or Chinese resources. And, like the tar sands, any new production will take a decade from decision to production.

Enhanced oil recovery covers a variety of techniques, and it will certainly result in more oil being produced at much higher prices. Almost all EOR methods have a low EREOI (thus their energy demands mitigate the net production gain) and they rarely have a strong effect on production rates. One could stereotype them as taking a depleted field, that was producing at, say, 5% of it's peak production and increasing this rate to 10% or 20% of peak at first but more importantly, extending production another one, two or more decades.

The fabled East Texas oil field still produces over 1 million b/day. Unfortunately, it is 99% water.

Every field is different and the effects of tertiary recovery vary significantly. Often there is nothing worth doing at any price, or it will only "pay" if natural gas is cheap and abundant locally.

I think of Enhanced Oil Recovery not as more oil now i.e. higher production rates, but as oil for longer, slower declines in "tail end" production rates.

OTOH, the last oil production left in Prudhoe Bay will rapidly head towards zero when natural gas production starts (Prudhoe Bay uses a combined water and natural gas drive). Although it is heading towards zero already. I found this tidbit about Prudhoe Bay:

The average well production rate was about 546 barrels of oil per day in 2001, 375 barrels per day in 2002, 350 barrels per day in 2003, 317 barrels per day in 2004 and 293 barrels per day in 2005.

Coal-to-Liquids is coming, but the Hirsch report for the Dept of Energy clearly showed that even with "maximum human effort" (i.e. WW II style building, with economics and environmental effects completely ignored) it will take 20 years to build 5 million b/day. 2 to 3 million b/day in 20 years is more likely with "maximum commercial effort". I could see CTL roughly equaling our continuing reductions in US domestic oil production (including ANWR) for basically flat US oil production.

Natural Gas-to-Liquids is a viable technology but there is little effort to build this yet. LNG

shipments and other uses appear to be more attractive. Qatar has one remaining project on the drawing boards AFAIK (another canceled). Again, very high capital costs and long lead times coupled with limited resource availability.

The EROEI of oil shale is too low for it to work on a large scale. Also slower than coal-to-liquids and there is no proven technology.

And that is it for viable supply side solutions in the next decade or two, even at 200 euros/barrel.

Better fuel economy in our current vehicle fleet will work for the US for about a decade IF oil production cuts are allocated evenly world-wide AND oil exports decline at a reasonably slow rate. However, I have made the argument that the US and the poorer third world nations are the "weak sisters" in economic competition for ever scarcer oil resources. And our "non-economic" efforts appear to be failing in Iraq and elsewhere. The Chinese appear to have out "stratergized" us.

$300 billion of our $760 billion trade imbalance is due to oil imports. Multiply oil prices and our exports are unlikely to increase much and our deficit will balloon. Our oil consumption (unlike Japan, Germany, France, etc.) continues to grow today and our domestic oil production continues to fall. As prices escalate, we may end up saturating world demand for dollars and dollar based assets. As with any desirable economic good, there is a limited demand at any reasonable price for the US $. Thus Japan and the EU may be forced to make minimal oil consumption cutbacks in the early years post-Peak Oil and the US will have to make disproportionate cutbacks.

Electric vehicles and even building more conventional hybrids face resource issues in quickly scaling up production world-wide. Waiving air pollution and perhaps safety requirements and accepting many more small diesel cars may be a more realistic near term option for the US. Even so, the "natural" turn-over in the US vehicle fleet is likely too slow to keep up with post-Peak Oil supply reductions.

One of my prime arguments is that the US burns over 2 million barrels/day in long haul heavy trucks (and over 250,000 in railroads). Shifting freight from heavy trucks to electrified railroads could trade 20 BTUs of diesel for 1 BTU of electricity with auxiliary benefits for safety, road maintenance, congestion, etc. And, in a prolonged oil supply shortfall, having a non-oil transportation alternative for critical goods (and some passengers) would be an invaluable strategic asset.

That good Republican Eisenhower originally wanted tolls on the interstate highways and that is a simple way to promote the shift. The truck ROW is exempt from property taxes, so I also advocate exempting from property taxes any rail line that electrifies. Add tolls to interstates and exempt electrified rail lines from property taxes and let the free market adjust to the reduction in subsidies and a more level playing field. Other, more complex gov't policies can work as well.

More efficient vehicles in the US is a short term fix (maybe enough for a few years, maybe not) but medium term and longer term fixes will require a change in our Urban form to a more energy efficient Urban form.

One essential piece to a more efficient Urban form is electrified Urban Rail that people, businesses and government agencies can cluster around, I have prepared a list of "on-the-shelf" Urban Rail projects that could start construction in 1 to 3 years with 90% federal funding (the same % as interstate highways). Roughly $130 to $160 billion could save roughly 4% of US oil consumption in a dozen years and more as Transit Orientated Development matured around these specific

"Phase I" lines. Longer term, a repeat of the 1897-1916 effort (when the US was considerably smaller and much poorer) could build subways in the largest cities and light rail/streetcars in 500 cities and towns (as we did before with "coal, mules and sweat").

A good model is the changes resulting from government policies from 1950 to 1970. The US trashed virtually all of the prime commercial real estate circa 1950 (downtowns) and much of the preWW II housing stock. Just do the same in reverse with a combination of gov't policies and economic forces, and hopefully a bit quicker. Build the carrot and just let the market (post-Peak Oil) be the iron rod (it will not be a stick !)

There will be numerous auxiliary benefits where walking and transportation bicycling are viable alternatives and Urban Rail is a dominant alternative transportation mode to short range EVs. And it is the only viable large scale urban alternative 25 years post-Peak Oil. The oil that is available will be needed for specialty applications.

Best Hopes,

Alan